
Space Weather Technical Forecast

Issued on Friday, 21 June 2024 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further M-class flares (R1-R2 radio blackouts) expected. Chance of isolated X-flares (R3 radio blackouts). Chance of S1/Minor radiation storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate with the peak flare observed at M5.7 level at 20/2316 UTC from AR3719. There are eight sunspot regions on the disc, the largest of these all lie in the western hemisphere. AR3712, AR3713 and AR3716 all underwent growth and consolidation of their component regions, with the latter two groups observed to increase in size the most during the period. All three regions contain one or more delta configurations. Despite this they appear stable at this time, with limited flaring observed. AR3719 and AR3720, in the far southeast, appear as smaller bipolar regions with the southernmost and most actively flaring region, AR3719, continuing a slight growing trend. The as yet unnumbered regions in the southwest and northeast are small and simple at this time, similar to AR3718.

No Earth directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, indicated declining fast wind influence from CH45/+. Wind speeds fell from elevated levels, peaking at 520km/s, to slightly elevated (420-450km/s). Density was below average throughout. Interplanetary Magnetic Field, Bt, was weak, below 6nT. The north-south component, Bz, varied weakly between +/-4nT. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 remained at background levels with no solar radiation storms occurring. High energy electron flux (greater than 2MeV) observed by GOES16 was predominantly moderate, reaching 561 pfu at 20/1730 UTC. The 24-hour fluence was below Active on a rising, then steady trend, reaching 1.7e7 integrated pfu at 21/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-flares are expected, with a chance of isolated X-class flares, most likely from AR3712, AR3713, AR3716 and AR3719.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the forecast period. Ongoing coronal hole influence should continue to ease on day 1 (21 Jun) with winds expected to reduce to background from slightly elevated levels. A further enhancement from the large coronal hole in the northwest disc is possible on days 1 and 2 (21 and 22 Jun), however, significant connection to this feature is considered unlikely given its high-latitude location on the disc. If a connection were to be forthcoming, speeds could reach slightly elevated to elevated levels. Any geomagnetic response, however, is expected to be limited at this time of year. No other potential coronal hole enhancements feature in the period.

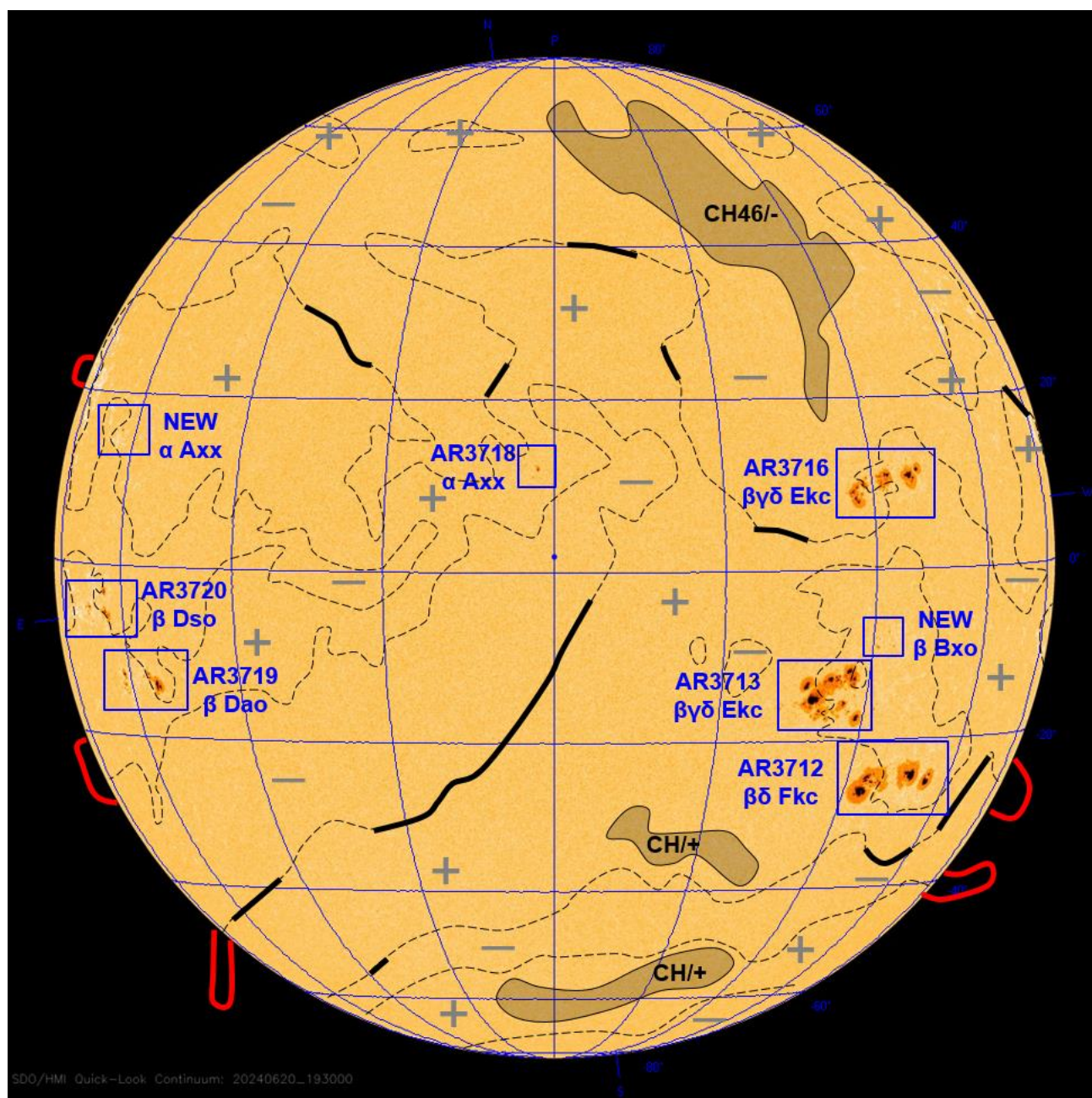
Overall mainly Quiet to Unsettled geomagnetic activity is expected. There is a chance of isolated

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Active intervals, mainly on day 1 and 2 (21 and 22 Jun), should there be any notable connection to the high-speed stream enhancement from the aforementioned large coronal hole.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background levels, but with a chance of exceeding the S1/Minor Storm threshold should any notable flares occur, predominantly from any of the three large spots in the western hemisphere. High energy electron flux is forecast to be at mainly moderate levels on days 1 and 2 (21 and 22 Jun), before likely declining to become predominantly background later in the period. The associated 24-hour fluence is expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 20/1930 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs feature in the forecast period.

Solar winds are currently slightly elevated due to waning effects of CH45/+, and are expected to decline to background levels on day 1 (21 Jun) as the coronal hole continues to rotate away. MOSWOC Enlil is indicating a significant enhancement from large coronal hole, CH46/-, in the northern disc on day 1 (21 Jun), however it is suggesting that Earth should already be entering this High Speed Stream (HSS). CH46/- is considered to be over-estimated in both strength and southern extent in Enlil, as well as too early with any potential onset. No significant enhancement was observed from this feature on the previous rotation, however, given the slightly more northward location of Earth above the ecliptic, a minor enhancement may be observed on days 1 and 2 (21 and 22 Jun). In the case of any connection to this feature, wind speeds would potentially increase to slightly elevated, or perhaps elevated levels, by the end of Day 2 or into Day 3 (22-23 Jun). Either way, any geomagnetic response is expected to be limited at this time of year (around the solstice). No other potential coronal hole enhancements feature in this period.

Overall mainly Quiet to Unsettled geomagnetic activity is expected. There is a chance of isolated Active intervals, mainly on day 1 and 2 (21 and 22 Jun), should there be any notable connection to the high-speed stream enhancement from the aforementioned CH46/-.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	10	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

Radio Blackouts - X-Ray Flares:

There are eight sunspot regions on the disc, with the three largest and most complex regions located in the western hemisphere. The largest region remains AR3712 in the southwest, with a slight increase in overall size, but limited change in the appearance and orientation of its numerous large spots. The region retains a weak delta region in the trailing portion of the group. AR3713, also in the southwest, continues to see consolidation in the interior spots of the group and retains multiple delta configurations. AR3716, located in the northwest, has also increased in size, mainly in the intermediate and trailing portion of the group, with further consolidation of its spots. Despite this, the three regions appear stable at this time, with limited flaring observed. AR3719 and AR3720, in the far southeast, appear as smaller bipolar regions with the southernmost and most actively flaring region, AR3719, continuing a slight growing trend. The as yet unnumbered regions in the southwest and northeast are small and simple at this time, similar to AR3718.

AR3712 and AR3716 are due to rotate off the visible disc on day 4 (24 Jun), but will still pose a threat for significant flares just beyond the western horizon.

There are a number of potential returning regions in the period, including one currently located near the northeast limb. This region is significantly foreshortened in coronagraph imagery at present, complicating analysis. Magnetic looping evident in SDO/AIA 171 imagery suggests another region approaching the northeast horizon following this. Far-sided seismic data also indicates a region due to return on day 4 (24 Jun) and is likely Ex-AR3664/Ex-AR3697), although may be significantly altered from when it was last on the visible disc earlier in June.

Solar activity is Moderate, with the peak flare at M5.7 level, observed 20/2316 UTC from AR3719. Further M-class flares are expected, with a chance of isolated X-class flares, most likely from AR3712, AR3713, AR3716 and AR3719.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	90	90
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 2: SDO/AIA HMI Intensitygram (left) and HMI Colorized Magnetogram (right) for AR3716, AR3713 and AR3712.

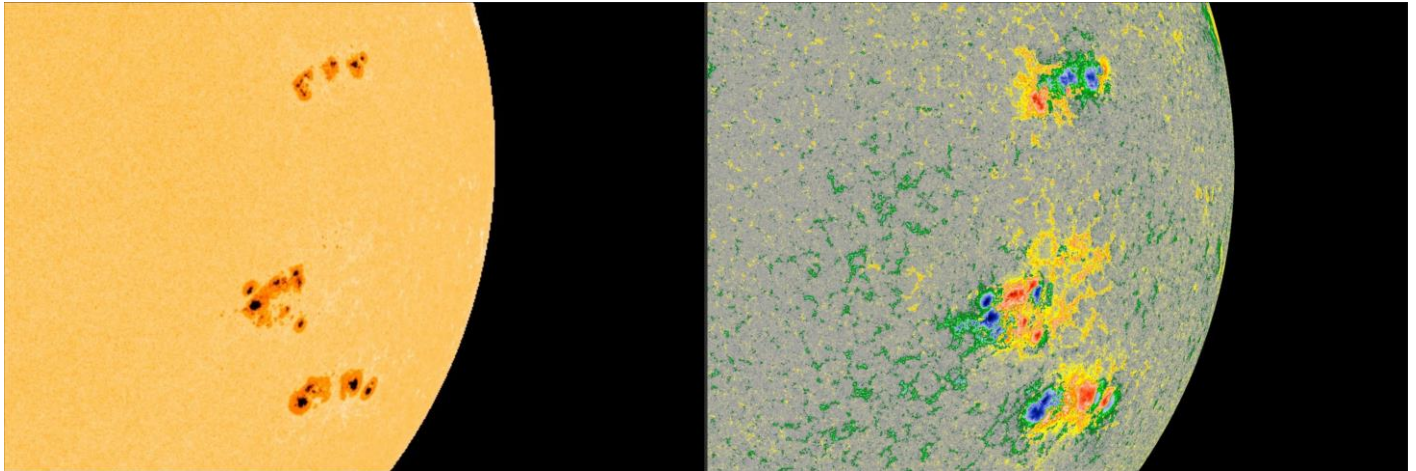


Figure 3: Latest GOES16/18 X-Ray Flux



Solar Radiation Storms - (High Energy Protons):

GOES-18 proton flux remains at background levels, with no solar radiation storms observed. However, any significant flares, particularly from any of the three larger regions (AR3712, AR3713 or AR3716) in the western disc, have the potential to increase the observed flux and brings a chance of exceeding the S1 Minor Storm threshold.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	30	30	30	30
Very Active	$\geq \text{S3}$ *	No	5	5	5	5

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux, as observed by GOES-16, reached predominantly moderate levels as a consequence of the relaxation of the Van Allen belts following the fast wind enhancement from CH45/+. Electron flux is likely to continue at mainly moderate levels on days 1 and 2 (21 and 22 Jun), perhaps briefly reaching high levels at diurnal maxima, before declining later in the period to become mainly background. A more pronounced decline would be expected on days 1 and 2 should the potential connection to CH46/- be stronger than anticipated.

Despite the recent increase, associated electron fluence is expected to persist below the Active threshold (1e8 integrated pfu), with MOSWOC REFM output considered to be good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1



Figure 4: Latest GOES16 >2MeV Electron Flux (above) and MOSWOC REFM forecast with recurrence (below)

